US-PAT-NO: 6128407

DOCUMENT-IDENTIFIER: US 6128407 A

TITLE: Image processing apparatus, image processing method, and image processing system

DATE-ISSUED: October 3, 2000

US-CL-CURRENT: 382/167, 358/504

APPL-NO: 08/ 855841

DATE FILED: May 12, 1997

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	8-118026	May 13, 1996
JP	8-345762	December 25, 1996
JP	9-89655	April 8, 1997

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Brief Summary Text - BSTX (3):
Image processing includes color conversion processing of executing color conversion for color image data so that the color image data falls within the color reproduction range of the device for visualizing the color image data.

For example, to output a color image to a **CRT or a printer,** not all colors can be represented and only colors within the color reproduction range of the device are output. When input color image data has a portion beyond the color reproduction range, color conversion processing is required for converting unreproduced colors beyond the color reproduction range into reproducible colors.

Detailed Description Text - DETX (8):
The image output device 7 is a machine that can output color images, such as a **printer or CRT**. It outputs an image based on the output image data from the interpolator 6. The image output device 7 may store data in a recording device, and transfer data to another device via a network, bus, etc., for example, without actual output.

Detailed Description Text - DETX (293):
In the examples shown in FIGS. 49 and 50 as the area to be processed to hold the hue, the area containing the division color area as shown in FIG. 49 is selected for the hue, the area containing the division color area and up to L*=50 as shown in FIG. 50 is selected for the lightness, and the area containing the division color area from C*=**0 is selected for the chroma** for setting the area to be processed for each division color area outside the color reproduction range. The numeric value of L*=50 for defining the lightness area

can be set to any value. To set each area, some margin can be provided.

Detailed Description Text - DETX (295):

H1+.alpha.H1 to H2+.alpha.H2, lightness 50 to L2+.alpha.L, and **chroma 0** to C2+.alpha.C.

US-PAT-NO: 6459501

DOCUMENT-IDENTIFIER: US 6459501 B1

TITLE: Small-gamut colorant set

DATE-ISSUED: October 1, 2002

US-CL-CURRENT: 358/1.9, 358/502 , 358/515 , 358/518 , 358/520

APPL-NO: 09/ 280232

DATE FILED: March 29, 1999

PARENT-CASE:

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/080,796, filed Apr. 6, 1998.

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Brief Summary Text - BSTX (36):

This category includes nearly all conventional photographic systems and some digital ones: color film, color printing paper and color photographic prints of nearly all types, film recorders, computer **monitors** and televisions, dye sublimation **printers, printers** that use lasers, LED's or laser diodes to print

onto photographic print materials containing silver, etc.

Detailed Description Text - DETX (38):
The following are descriptions of ways in which either of the principal embodiments may be further limited. For example, a small gamut colorant set for printing mechanisms capable of printing from digital data includes three tinting colorants as specified for either embodiment above plus a fourth, black colorant having a possible range of L values between **0 and 30 with a range of chromas between 0** and 30, and any hue angle.

Detailed Description Text - DETX (39):
Another example is a small gamut colorant set for printing mechanisms capable of printing from digital data that includes two sets of three tinting colorants each, as specified for either embodiment above, plus a seventh, black colorant having a possible range of L values between **0 and 30 with a range of chromas between 0** and 30, and any hue angle. The average L value of the two sets of tinting colorants differ from one another by at least 30 in the L scale. The difference in L value between the cyan, magenta and yellow tinters, respectively, is at least 20 (lighter cyan minus darker cyan equals at least 30, etc.). The two sets of tinting colorants are used in the system to predominate in different regions of the L scale, thus yielding potentially superior image smoothness.

Detailed Description Text - DETX (41):
Yet another small gamut colorant set for printing mechanisms capable of printing from digital data includes three tinting colorants as specified in either of the two embodiments above. A fourth, black colorant has a possible range of L values between 0 and 30. **Chromas range between 0** and 50 at an L value of 0. **Chromas range between 0** and 10 at an L value of 30, but in no case have a chroma value higher than any of the tinting colorants when printed to any same L value as any of the tinting colorants, and any hue angle. Further included is a fifth, gray colorant having a possible range of L values between 20 and 90 and a range of **chromas for each L value that is between 0 and the lowest chroma** of any of the tinting colorants printed to the same L value, including by printing at less than solid coverage or less than maximum density or both.

Detailed Description Text - DETX (43):
Yet another variation of the first and second embodiments is a small gamut colorant set for printing mechanisms capable of printing from digital data which includes three tinting colorants as specified for the first or second embodiments. Further included is a fourth, black colorant having a possible range of L values between **0 and 30 with a range of chromas between 0** and 30, and any hue angle. A fifth, gray colorant has a

possible range of L values between 20 and 90 and a range of **chromas for each L value that is between 0 and the lowest chroma** of any of the tinting colorants printed to the same L value, including by printing at less than solid coverage or less than maximum density or both A sixth, gray colorant has a possible range of L values between 40 and 96 and a range of **chroma for each L value that is between 0 and the lowest chroma** of any of the tinting colorants printed to the same L value, including by printing at less than the solid coverage or less than the maximum density or both. The sixth, gray colorant differs in L value from the fifth, gray colorant by at least 20.

Detailed Description Text - DETX (66):

ICC device profiles can be made for presses using the small-gamut method, enabling accurate simulation of the printed sheet with soft proofing (on a **monitor**), digital proofing (on a digital **printer** of any kind), and with film-based proofs (such as MatchPrint, WaterProof, AgfaProof, etc.)--as soon as someone makes the necessary 3-hue gray donor sheets for film-based proofing. Traditional printing systems for monochrome (duotone, tritone and quadtone) cannot be profiled for color management, so none of the digital proofing methods can readily be used or used well with such printing, and film-based (optical) proofing systems usually can't be used with duotone, et al., partly because the dot gains involved with typical 300

lines per inch duotone are too
great for optical proofing systems designed for
color work to simulate and
because the proofing systems do not supply the
correct color donors (especially
the gray or grays).

Detailed Description Text - DETX (76):

ICC device profiles can be made for presses
using the small-gamut method,
enabling accurate simulation of the printed sheet
with soft proofing (on a
monitor), digital proofing (on a digital **printer** of
any kind), and with
film-based proofs (such as MatchPrint, WaterProof,
AgfaProof, etc.)--as soon as
someone makes the necessary 3-hue gray donor sheets
for film-based proofing.

US-PAT-NO: 5937089

DOCUMENT-IDENTIFIER: US 5937089 A

TITLE: Color conversion method and apparatus

DATE-ISSUED: August 10, 1999

US-CL-CURRENT: 382/167, 358/518 , 358/520

APPL-NO: 08/ 949299

DATE FILED: October 13, 1997

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	8-291061	October 14, 1996
JP	9-243444	August 25, 1997

---------- KWIC ---------

Brief Summary Text - BSTX (3):

Color conversion becomes necessary when, for example, a color image generated in a computer for display on a cathode-ray-tube **(CRT) monitor** is printed on paper by an ink-jet color **printer,** or an electrophotographic color **printer**. The **CRT** employs additive color mixing of the three primary colors

red, blue, and green. The color **printer** employs subtractive color mixing of inks (or toner) of the three primary colors cyan, magenta, and yellow, or the four colors cyan, magenta, yellow, and black. The **CRT** can generally reproduce a larger gamut of colors than the **printer,** so a color conversion or mapping process is required. Various methods have been proposed.

Brief Summary Text - BSTX (4):
Japanese Kokai Patent Application 88589/1993 describes a method of projecting the **CRT's** color space onto the **printer's** color space along lines linking each color to the white point on the chromaticity diagram. For each such line, the ratio of the most saturated color reproducible by the **printer** to the most saturated color reproducible by the **CRT** is determined, and the entire line is contracted or expanded by that ratio.

Brief Summary Text - BSTX (8):
A problem with both of these methods is that the white point on the chromaticity diagram of the **CRT** rarely coincides with the white point on the chromaticity diagram of the **printer**. The white point of a color **printer** is the paper white color: the color of the paper on which the image is printed, which virtually never matches the white point of the **CRT**. A further complication is that in a color **printer,** differing from a **CRT,** the chromaticity coordinates of the color black (either the color of the black ink,

or the color black as reproduced by mixing cyan, magenta, and yellow) rarely match the chromaticity coordinates of the color white. As a result, when the above methods are applied, hues are altered, points that should be white, gray, or black become tinged with color, and the quality of the printed image is visibly degraded.

Detailed Description Text - DETX (10):

It will be assumed that the input colors described below have been generated for reproduction by a color display device, e.g. a color **CRT monitor,** and that the output colors will be reproduced by a color **printer** using inks with the primary colors cyan, magenta, and yellow.

Detailed Description Text - DETX (34):

CIE LAB color coordinates will be used in the second embodiment. The input white axis (the line joining the input white and black colors) will be assumed to have **chromaticity coordinates of zero (a*=0** and b*=0).

US-PAT-NO: 6101272

DOCUMENT-IDENTIFIER: US 6101272 A

TITLE: Color transforming method

DATE-ISSUED: August 8, 2000

US-CL-CURRENT: 382/167, 358/520

APPL-NO: 08/ 990006

DATE FILED: December 12, 1997

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	8-332037	December 12, 1996
JP	8-332043	December 12, 1996
JP	9-138853	May 28, 1997

---------- KWIC ---------

Abstract Text - ABTX (1):
The improved color transformation method comprises determining for each pixel a lightness component specified between a maximum and a minimum value for three signals and chromaticity components obtained by excluding the lightness component from the three signals, amplifying or attenuating the thus obtained

chromaticity components in accordance with the three signals and adding them to the lightness component amplified or attenuated in accordance with the three signals. Even if the input original image is a subject, a transmission original **hardcopy** image, a reflection original **softcopy** image or an original **softcopy** image, one can create a reproduced **hardcopy** image such as a reflective print which is extremely faithful to the input original image or, alternatively, one can provide a **monitor** display of a reproduced image (a reproduced soft copy image) which is also extremely faithful to the input original image. The processing system is very simple and permits realtime execution. Even transmission original **hardcopy** images and original **softcopy** images which are upset in either color balance or density balance or both can be effectively processed to yield reproduced reflection **hardcopy** image or reproduced **softcopy** images which feature good balances.

Brief Summary Text - BSTX (2):

This invention relates to a color transforming method which intends to achieve visually faithful or preferred color reproduction of color images. More particularly, the invention relates to a color transforming method by which input digital image data are converted to the image signals required for the original image in an input (color space) system to be reproduced faithfully in an output (color reproduction) system having a

different color gamut (color space) such as a different dynamic density range than in the input (color space) system, as well as a color transforming method for achieving transformation to image signals that are required to ensure that the important colors are reproduced preferably, that is, in a visually preferred lightness level, whether the input color space is the same as the output color space or not. More specifically, the invention relates to a color transforming method by which image signals read with a scanner or the like from transmission or reflection original **hardcopy** images obtained by photographing a subject on reversal films or negative films, or image signals obtained by photographing a subject directly with a solid-state imaging device such as a CCD, or image signals of an image displayed on a **TV monitor** are converted to the digital signals that are required for creating reproduced reflection **hardcopy** images visually faithful to the transmission original **hardcopy** images, the subject, the **monitor** and the like, or reproduced reflection **hardcopy** images on which the important colors are reproduced in a visually preferred lightness level, or for displaying reproduced **softcopy** images on the **monitor** or the like which are visually faithful to the transmission originals, reflection original, the subject and the like, or reproduced **softcopy** images on the **monitor** or the like in which the important colors are reproduced in a visually preferred lightness level.

Brief Summary Text - BSTX (10):
Fidelity as perceived by the eye is also required by **TV monitors,** video projectors and other machines that produce **softcopy** images; when subjects photographed with digital cameras, video cameras, etc. or images on transmission and reflection original **hardcopy** images as read with scanners, etc. are to be displayed as reproduced **softcopy** images on **TV monitors,** video projectors, etc. or when original **softcopy** image displayed on **TV monitors,** video projectors, etc. are to be replicated on reflection reproduced **hardcopy** images, it is required to reproduce output **softcopy/hardcopy** images that are faithful to the input **hardcopy/softcopy** as perceived with the eye. However, color gamut such as the dynamic density range do not necessarily coincide between the input and output spaces and the various problems described in the preceding paragraphs exist.

Brief Summary Text - BSTX (18):
A second object of the invention is to provide a color transforming method that is capable of producing reproduced reflection **hardcopy** images or reproduced **softcopy** images having an extremely high fidelity to transmission original **hardcopy** images, subjects or original **softcopy** images and which permits the required image processing to be executed realtime and easily using a very simple processing system.

Brief Summary Text - BSTX (19):
A third object of the invention is to provide a color transforming method which, in addition to attaining the two stated objects, enables reproduced reflection **hardcopy** images or reproduced **softcopy** images of good color and density balances to be prepared realtime and easily by means of a very simple processing system even if the input is transmission original **hardcopy** images which are upset in color or density balance or original image signals which are not appropriate in terms of exposure or display conditions.

Brief Summary Text - BSTX (22):
A fifth object of the invention is to provide a color transforming method which is capable of outputting a reproduced reflection **hardcopy** image or a reproduced **softcopy** image on which the colors of a transmission original **hardcopy** image, subject or original **softcopy** image are properly reproduced, with the important colors being selectively finished to a visually preferred lightness level and which is capable of executing the necessary image processing procedures by a simple processing system in a realtime and convenient manner.

Detailed Description Text - DETX (4):
In the following description of the second embodiment of the invention, the

input image on the **hardcopy or softcopy** is a color positive image on a reversal film; however, the invention is in no way limited to this particular **hardcopy** and any input will suffice if it can be transformed to the above-defined signals such as END and integral END (hereunder sometimes abbreviated as IND). For example, the invention is also applicable to a system in which a subject is directly imaged with a solid-state imaging device such as CCD, more specifically a digital camera or a video camera, to record it as digital image signals, which are then output on a reflective print, as well as to a system in which a subject is photographed on a color negative film and the resulting color negative

Detailed Description Text - DETX (7):

As already mentioned in connection with the prior art, it is desirable for range compression to be performed in such a way as to satisfy four requirements, i.e., description of highlights and shadows and the preservation of contrast, chroma and hue. In spite of these four requirements to be satisfied, the degrees of freedom that are allowed are three B, G and R. In other words, if the four requirements are independent of one another, they cannot be satisfied simultaneously. In range compression, it is critical to determine which are possible and which are not. In the present invention, fidelity to originals (**hardcopy or softcopy** images), especially color

transparency **hardcopy** images, is of prime importance, so the preservation of hues and the description of highlights and shadows are performed. For the sake of simplicity, the following description assumes the use of a system of block dyes which have rectangular absorption waveforms and which produce a gray when the densities of B, G and R coincide.

Detailed Description Text - DETX (45):

Parameter k.sub.1 (or k) which is also referred to as a lightness coefficient may be set at appropriate values that satisfy 0<k.sub.1 (k)<1.0 in accordance with the dynamic density range of the input image on the **hardcopy or softcopy** (e.g. a color positive image on a reversal film) or the subject, as well the dynamic range of the densities that can be reproduced on the output reflection print. Considering the dynamic density range ratio for the case where the image on a reversal film is output as a reflection print, human vision and other factors, the parameter k.sub.1 (or k) is preferably set at a numerical value within the range that satisfies 0.7<k.sub.1 (or k)<1.0. More preferably, parameter k.sub.1 (or k) is within a range that satisfies 0.75.ltoreq.k.sub.1 (or k).ltoreq.0.9. Speaking of parameter k.sub.0 (also called chroma coefficient), it is not limited to any particular value and may appropriately be set in accordance

Detailed Description Text - DETX (47):

In the foregoing example, in order to accommodate the white background D.sub.rW of a reflection medium such as a reflection print paper, min.sub.(xy) D.sub.A which is the smallest value that can be taken by the lightness component is used to represent the brightest point (pixel point represented as x and y coordinates) in the image on the original (**hardcopy/softcopy** image). This is not the sole case of the invention and a constant which does not depend directly upon the lightness component D.sub.A of the image on the original may be substituted, with the value being selected from the range of 0.0-0.3, preferably 0.1-0.2. The specific value of this constant depends on various factors including the environment for exposure of the subject such as the exposure light source, the base density of the transparent medium as the original on which the input image is formed, the transparent medium per se and the three or more colorants it uses, as well as on the reflection medium such as a reflection print and the colorants it uses, which may be taken into account as required. As already mentioned, the constant may appropriately be selected from the range of 0.0-0.3.

Detailed Description Text - DETX (106):

If no specific color corrections such as the adjustment of chromaticity and chroma or the reproduction of a preferred color are to be performed, the coefficients of color correction k.sub.01, k.sub.02

and k.sub.03 may assume an identical value k.sub.0 (**chroma coefficient k.sub.0 >0**). In this case, the set of equations (1) may be rewritten as follows: ##EQU14##

Detailed Description Text - DETX (111):

As shown in FIG. 3, the thus obtained color transformed signals B', G' and R' (or N'.sub.X, N'.sub.Y and N'.sub.Z) are replicated as a reproduced image faithful to the original image such as the subject, the image on the original or the image displayed on a **monitor**, either immediately or after transformation to device-dependent data (DDD) signals. Consider, for example the case where the output device is a **printer**. If the obtained color transformed signals B', G' and R' (or N'.sub.X, N'.sub.Y and N'.sub.Z) already have **printer**-dependent optical densities B', G' and R', they are immediately input to the **printer**; if not, they are transformed to **printer**-dependent optical densities B', G' and R', which are then input to the **printer**. In either case, the **printer** replicates the **printer**-dependent optical densities B', G' and R' on the reflection medium to yield a reflection reproduced image (print) faithful to the original image. If the output device is a **monitor**, the obtained color transformed signals B', G' and R' (or N'.sub.X, N'.sub.Y and N'.sub.Z) are immediately input to the **monitor** if they are already **monitor**-dependent; if not, they are transformed to **monitor**-dependent signals (B',G',R'), which are then input to the **monitor**. In

either case, the **monitor** displays a replication of the **monitor**-dependent signals to yield a **monitor** displayed reproduced image faithful to the original image.

Detailed Description Text - DETX (181):
If no specific color corrections such as the adjustment of chromaticity and chroma or the reproduction of a preferred color are to be performed, the coefficients of color correction k.sub.01, k.sub.02 and k.sub.03 may assume an identical value k.sub.0 (**chroma coefficient k.sub.0 >0**) . In this case, the set of equations (14) may be rewritten as follows: ##EQU24##

Detailed Description Text - DETX (183):
As shown in FIG. 7, in the same way as in the first embodiment, the thus obtained color transformed signals B', G' and R' are sent to a **printer or a monitor,** where these signals are replicated as a reproduced reflection image (print) or a reproduced image displayed on a **monitor** on which the

Detailed Description Text - DETX (188):
1) Even if the input original image is a subject, an image on a transmission original (a transmission original **hardcopy** image), an image on a reflection original (a reflection original **hardcopy** image) or an image displayed as on a **monitor** (an original **softcopy** image), one can create a reproduced **hardcopy**

image such as a reflective print which is extremely faithful to the input original image or, alternatively, one can provide a **monitor** display of a reproduced image (a reproduced **softcopy** image) which is also extremely faithful to the input original image.

Detailed Description Text - DETX (191):
4) Even transmission original **hardcopy** images and original **softcopy** images which are upset in either color balance or density balance or both can be effectively processed to yield reproduced reflection **hardcopy** images or reproduced **softcopy** images which feature good balances.

Detailed Description Text - DETX (192):
5) Even if the input original image is a subject, an image on a transmission original, an image on a reflection original or an image displayed as on a **monitor,** one can create a reproduced **hardcopy** image such as a reflective print on which the colors of the input original image are properly reproduced and which has the important colors, in particular the color of the skin of the face and the blue sky color, finished in a visually preferred lightness level to give a natural impression in a satisfactory and highly precise manner, with the skin color rendered relatively light and the blue sky color relatively deep or, alternatively, one can provide a **monitor** display of a reproduced image (soft copy image) on which the colors of the input

original image are also properly
reproduced and which has the important colors, in particular the color of the
skin of the face and the blue sky color, finished in a visually preferred
lightness level to give a natural impression in a satisfactory and highly
precise manner, with the skin color rendered relatively light and the blue sky
color relatively deep.

Detailed Description Text - DETX (230):
The transformed image data were output with a color **printer** (Pictrography
3000) to yield a reflection print faithful to the **monitor** image.

Detailed Description Text - DETX (233):
The transformed image data were further transformed to calorimetric values
which were output to a color **printer** (Pictrography 3000) managed with
calorimetric values in which the white background of the photographic paper was
a reference white. As a result, there was yielded a reflection print faithful
to the **monitor** image.

Claims Text - CLTX (71):
15. The color transforming method as set forth in claim 1, wherein said
image input device is one of a scanner, a digital camera, a video camera, a
monitor, and a video projector, and said image output device is one of a
printer, a monitor, and a video projector.

Claims Text - CLTX (72):

16. The color transforming method as set forth in claim 1, wherein said image input device is one of a scanner and a digital camera, and said image output device is one of a **printer and a monitor**.

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US-PAT-NO: 6151136

DOCUMENT-IDENTIFIER: US 6151136 A

TITLE: Color transforming method

DATE-ISSUED: November 21, 2000

US-CL-CURRENT: 358/1.9, 358/518 , 382/163 , 382/166

APPL-NO: 09/ 062557

DATE FILED: April 20, 1998

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	9-101880	April 18, 1997

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Detailed Description Text - DETX (14):

As in the case of the calorimetric converting unit at the input end 22, the output device contemplated, as well as the data on calorimetric values, device-dependent data and the method of color transformation (which is by inverse mapping and any known techniques of inverse mapping will do) to be employed in the calorimetric converting unit at the output end 26 are by no means limited to the cases described above and any

known versions may be applied. For example, the output device may be a photographic **printer,** a copier or a display apparatus such as a **CRT**. The device-dependent data may be CMY or RGB data.

Detailed Description Text - DETX (45):

FIG. 7A shows an example of the lightness L* dependent function Lci which is to be used in the invention, and FIG. 7B shows an example of the chroma Cab* dependent function Cci which is also to be used in the invention. Referring to the lightness L* dependent function Lci shown in FIG. 7A, lightness L*=90 is a constant for the density of the paper to be used in printing and L*=10 represents the maximum ink density to be adopted in printing. Referring to the chroma Cab* dependent function Cci shown in FIG. 7B, chroma Cab*=50 which is saturated at a function value Cci=1.0 represents the **maximal chroma** value in the color gamut to be reproduced in printed matter.

US-PAT-NO: 5428465

DOCUMENT-IDENTIFIER: US 5428465 A

TITLE: Method and apparatus for color conversion

DATE-ISSUED: June 27, 1995

US-CL-CURRENT: 358/518, 345/600 , 358/523 , 358/525

APPL-NO: 07/ 928373

DATE FILED: August 12, 1992

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	3-201675	August 12, 1991
JP	3-277428	October 24, 1991

---------- KWIC ---------

Brief Summary Text - BSTX (3):

The present invention relates to a color conversion in which color image signals or color video signals are inputted and transformed into desirable colors, for example, utilized for a color **hard copy** apparatus, a color display apparatus, a color **TV** camera apparatus, a color

recognition apparatus, a video
editing apparatus and the like.

Detailed Description Text - DETX (66):
Then, if the **chromaticity signals obtained after assigning these values from** **0** to 255 in order to express them in normal forms are referred to Cr, Cb, these Cr and Cb are calculated as follows:

US-PAT-NO: 6437792

DOCUMENT-IDENTIFIER: US 6437792 B1

TITLE: IMAGE PROCESSING APPARATUS AND METHOD, COLOR GAMUT CONVERSION TABLE CREATING APPARATUS AND METHOD, STORAGE MEDIUM HAVING IMAGE PROCESSING PROGRAM RECORDED THEREIN, AND STORAGE MEDIUM HAVING RECORDED THEREIN COLOR GAMUT CONVERSION TABLE CREATING PROGRAM

DATE-ISSUED: August 20, 2002

US-CL-CURRENT: 345/600, 345/590 , 345/601 , 345/603

APPL-NO: 09/ 488617

DATE FILED: January 20, 2000

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	11-014515	January 22, 1999
JP	11-200838	July 14, 1999

---------- KWIC ---------

Brief Summary Text - BSTX (12):

FIG. 2 shows a typical color gamut of CRT monitor and a typical color gamut of printer, integrated in the direction of L* and plotted in a plane a*-b*. Normally, the CRT monitor and printer color gamuts are different from each other as shown in FIG. 2. As seen from FIG. 2, the color gamut of the printer color is generally smaller than that of the CRT monitor, and especially in the green and blue color gamuts, the printer color gamut is extremely smaller than the CRT monitor color gamut. FIG. 3 shows the typical color gamut of CRT monitor and that of printer, plotted in a plane C*-L*. Since the peak of the **chroma** C* in the CRT monitor color **gamut** is away from that of the **chroma** C* in the printer color **gamut** in the direction of **lightness** L* as shown in FIG. 3, it is physically impossible for the printer to reproduce a color in an area of a high **lightness and chroma** displayed on the CRT monitor even in the domain of a hue in which there is not so large a difference between the CRT monitor and printer as in FIG. 2.

Brief Summary Text - BSTX (18):

In the one-dimensional color **gamut** reduction, only one of **lightness, chroma** and hue is changed. Normally in this method, only the **chroma** should preferably be reduced while the **lightness** and hue are kept constant as shown in FIG. 6 (as having been suggested by R. S. Gentile, E. Walowit and J. P. Allebach in "A Comparison of Techniques for Color **Gamut** Mismatch Compensation", J. Imaging

Tech., 16, pp. 176-181, (1990)).

Brief Summary Text - BSTX (19):

In the two-dimensional color **gamut** reduction, two of **lightness, chroma** and hue are changed. Normally in this two-dimensional color **gamut** reduction, the **chroma and lightness** should preferably be reduced while the hue is kept constant. For the two-dimensional color gamut reduction, various techniques have been proposed. For example, E. G. Pariser proposed to reduce the **chroma and lightness** in the direction of (L*, a*, b*)=(50, 0, 0) with the hue kept constant as shown in FIG. 7 (in his "An Investigation of Color **Gamut** Reduction Techniques", IS&T Symp. Elec. Prepress Tech.--Color Printing, pp. 105-107. (1991)). Also, the Japanese Unexamined Patent Application Publication No. 9-98298 has disclosed a technique that a color gamut should be divided for each hue and each divided color gamut be mapped in an optimum color gamut reducing direction as shown in FIG. 8.

Brief Summary Text - BSTX (20):

In the three-dimensional color **gamut** reduction, **lightness, chroma** and hue are reduced. For such a three-dimensional color **gamut** reduction, the Applicant of the present invention has disclosed in the Japanese Unexamined Patent Application Publication No. 10-84487 a method of color **gamut** reduction in which each of three terms (**lightness** difference, **chroma** difference and hue

difference) in a color difference formula is weighted (with a reduction factor) and the color **gamut** is reduced in the direction of a minimum color difference.

Brief Summary Text - BSTX (28):

In the color **gamut** reduction disclosed in the Japanese Unexamined Patent Application Publication No. 10-84487, the three terms (**lightness, chroma** and hue differences) included in the color difference formula given by the equation (1-9) are weighted with factors K.sub.l, K.sub.c and K.sub.h (reduction factors), respectively, and then reduced in the direction of minimum color differences. Namely, on the assumption that the color difference formula is given by the equation (1-10), the color gamut is reduced for the color difference .DELTA.E given by the equation (1-10) to become minimum.

Brief Summary Text - BSTX (33):

Normally in the one- and two-dimensional color gamut reductions, the color gamut is reduced with the hue kept constant. For an image in colors of which many are outside the color **gamut,** however, the color **gamut** has to be reduced more in the direction of **lightness or chroma**. However, since the reduction of the color gamut of an image in the direction of lightness will reduce the contrast of the image, the more reduction of the color gamut in the direction of lightness will cause the whole image to lose a third dimension. On the

other hand, the reduction of the color gamut in the direction of chroma will lower the definition of the image. So, if the color gamut is reduced more in the direction of chroma will cause the image to give a reduced impact. Especially, if the one- or two-dimensional color gamut reduction is applied to an image created by the computer graphic, namely, an image having an extremely high chroma and a third dimension, these features of the image will be lost to a considerable extent.

Brief Summary Text - BSTX (34):
To apply a color **gamut** reduction to an image while maintaining such features thereof, the reduction ratio in the directions of **lightness and chroma** should be small while the hue is changed to some extent. This can be attained by the three-dimensional color gamut reduction.

Detailed Description Text - DETX (75):
The color **gamut** reduction effected in the L*C*h color space based on the three attributes (**lightness, chroma** and hue) obtained through the polar coordinate transform of a device-independent color space, will be described hereinbelow. Examples of the color gamuts of the monitor and printer in a certain hue are shown in FIGS. 31 and 32.

Detailed Description Text - DETX (86):
The parameter K may be of any value if only it is within the color gamut of

the printer. As shown in FIGS. 34 and 35, for example, the parameter K may be set on a **lightness** determined to have a maximum **chroma** in the printer color **gamut**. Otherwise, as shown in FIG. 36, the parameter K may be set on a straight line extending from a point having a maximum chroma in the printer color gamut to a point having a predetermined chromatic value (point of (*L, a*, b*)=(50, 0, 0) in the example shown in FIG. 26).

Detailed Description Text - DETX (89):

The parameter K may be of any value if only it is within the printer color gamut. For example, the parameter K may be set on a **lightness** determined to have a maximum **chroma** inside the printer color **gamut**, as shown in FIG. 37. Otherwise, the parameter K may be set on a **lightness** determined to have a maximum **chroma** in the color **gamut** common to the printer and monitor, as shown in FIG. 38. Moreover, the parameter K may be set on the straight line extending from the point having a maximum chroma in the printer color gamut to a point having a predetermined chromatic value, or it may be set on a straight line extending from a point having the maximum chroma in the color gamut common to the printer and monitor to a point having the predetermined chromatic value.

Detailed Description Text - DETX (92):

Next, there will be described how the color gamut of the point P existing in

the area A is reduced when the monitor and printer color gamuts have the shape 1 as in the above. Note that the colorimetric area is set in relation to the printer color **gamut** with the parameter K set on the straight line of **lightness** of the color **gamut** having the maximum **chroma** in the hue plane of the point P.

Detailed Description Text - DETX (109):
The evaluation function and its parameters may be the same for all color signals to be subjected to color gamut reduction, but they may be changed for each hue and each color area. Therefore, for those of color signals having to be reduced in color **gamut** which are outside the printer color **gamut, the lightness, chroma** and hue may be three-dimensionally reduced while for those which are inside the printer color **gamut, the lightness and chroma** may be two-dimensionally reduced.

Detailed Description Text - DETX (111):
Namely, when an input image color signal is inside the color **gamut** of the printer, only the **lightness and chroma** of the color signal may be changed using the color difference formula given by the equation (6-3) as the evaluation function while the hue is maintained. When the input image color signal is outside the printer color **gamut, the lightness, chroma** and hue of the color signal may be changed using the color difference formula given by the equation (6-4) as the evaluation function.

Detailed Description Text - DETX (114):
As in the foregoing, a color signal whose ratio between the distance from the outer wall of the colorimetric area and that from the outer wall of the monitor color gamut is m:n is mapped along the profile of the output device imaginary color gamut whose ratio between the distance from the outer wall of the colorimetric area and that from the outer wall of the printer color gamut is x:y. The above processing is effected all the to-be-reduced input image color signals. Thus, the linear or nonlinear reduction can be adopted to effect a color **gamut** reduction using the three-dimensions, namely, **lightness,** **chroma** and hue.

Claims Text - CLTX (6):
5. The apparatus as set forth in claim 2, wherein to reduce a color **gamut,** if the color signal of the image from the input device is inside the color **gamut** of the output device, the color **gamut** reducing means changes only the **lightness and chroma** of the color signal while maintaining the hue of the color signal; and if the color signal of the image from the input device is outside the color **gamut** of the output device, the color **gamut** reducing means changes the **lightness, chroma** and hue of the color signal.

Claims Text - CLTX (13):
11. The method as set forth in claim 7, wherein

to reduce a color **gamut,** if
the color signal of the image from the input device is inside the color **gamut**
of the output device, only the **lightness and chroma** of the color signal are
changed while the hue is maintained; and if the color signal of the image from
the input device is outside the color **gamut** of the output device, the
lightness, chroma and hue of the color signal are changed.

US-PAT-NO: 6411304

DOCUMENT-IDENTIFIER: US 6411304 B1

TITLE: Color data gamut conversion using three color lightness ranges in an apparatus, method, and computer-readable recording medium with a program making a computer execute the method recorded therein

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Brief Summary Text - BSTX (2):
The present invention relates to a color data conversion apparatus for converting first color data included in a first color gamut of color image

equipment such as a **CRT,** according to prespecified target color data within a second color gamut of another color image equipment such as a **printer,** to second color data within the second color gamut as well as to a color data conversion method and a recording medium for the same. More particularly, this invention relates to a color data conversion apparatus enabling efficient performance of color data conversion without increase in its lightness when an image fetched through a scanner is displayed on a **CRT** or a result of an image printed by a **printer** is reproduced on a **CRT** as well as to a color data conversion method and a recording medium for the same.

Brief Summary Text - BSTX (4):

Conventionally, color image equipment such as a **printer and a CRT** has, in many cases, a different color gamut. Therefore, there may arise a case where a color capable of being displayed on a **CRT** can not be printed. Disclosed in Japanese Patent Laid-Open Publication No. SHO 60-105376 (Conventional technology 1) is a color image output device for converting color data included in the first color gamut dependent on first color input/output equipment toward an achromatic color having the same lightness as that of the first color data tobe converted to second color data included in the second color gamut dependent on second color input/output equipment.

Brief Summary Text - BSTX (5):

FIGS. 13A and 13B explain the concepts of conventional color data conversion for converting color data included in a color gamut of a **CRT** to color data included in a color gamut of a **printer** on a L*a*b* space. An area 301 indicated by a broken line in these figures shows a color gamut of a **CRT,** and an area 302 indicated by a solid line shows a color gamut of a **printer** In this L*a*b* space, lightness becomes higher as an L* value is larger, chroma becomes higher as values of a* and b* become larger. Positive area of b* is mainly a yellow gamut, while negative area of b* is mainly a blue gamut.

Brief Summary Text - BSTX (6):

As shown in FIG. 13A, color data 303, 306, 309, and 312 displayable on a **CRT** are outside of the **printer** color gamut, therefore the color data 303, 306, 309, and 312 cannot be printed by a **printer** unless they are converted to data for a **printer**.

Brief Summary Text - BSTX (18):

FIGS. 14A and 14B explain the concepts of color data conversion based on the conventional technology 3 and the problems therein. As shown in FIG. 14A, in the conventional technology 3, color data 360 which is at the same hue angle as that of color data 343, 349, and 352 within the **CRT** color gamut 301 and also has the highest chroma of the **printer** color gamut 302 is linked with a color

data 361 for an achromatic color having the same lightness as that of the color data 360 with a line (corresponding to a dashed line 341 in FIG. 14A). Then, the color data 343, 349, and 352 as targets for conversion are converted toward color data 344, 350, and 353 located on this line, and color data after conversion 345, 351, and 354 are acquired.

Brief Summary Text - BSTX (21):
As described above, with the conventional technology 3, color data with higher chroma is converted toward color data with higher chroma on the line, therefore the problem (problem 1) in the conventional technology 1 and conventional technology 2 that chroma in color data decreases can be resolved, and also the problem (problem 2) that there exists color data incapable of being converted can be resolved. Furthermore, the problem (problem 3) that lightness values and chroma values of two color data are reversed can be resolved, so that extremely favorable color reproduction can be performed when a color displayed on a **CRT** is to be printed by a **printer**.

Brief Summary Text - BSTX (22):
Even if the conventional technology 3 is used, however, when a color image fetched with a color scanner is reproduced on a **CRT** display or when a result of an image printed by a **printer** is reproduced on a **CRT** display, there comes up a problem that the lightness of the color data after

the conversion increases.

Brief Summary Text - BSTX (23):
FIG. 14B explains this new problem when the conventional technology 3 is used. For convenience in description, herein the problem is explained with reference to a L*a* cross section of the L*a*b* space. It is assumed that an area 371 indicated by a broken line in the figure shows a color gamut of a **CRT** and an area 372 indicated by a solid line shows a color gamut of a color **printer** in a silver-salt photographic system. An a*-positive area is an area of mainly magenta, and an a*-negative area is an area of mainly green.

Brief Summary Text - BSTX (27):
The reason why the lightness value increases is, the **CRT** color gamut 371 forming color by light emission is substantially different from a shape of the color gamut 372 of a color **printer** forming color by reflection of illuminating light. More specifically, in the **CRT,** the lightness value of the color data 386 with the highest chroma in an area of green color is a quite high of around 80 to 90, and as a result, the line 373 indicated by a dashed line locates in a level of high lightness. On the contrary, in the color **printer,** the lightness value of the color data 388 with the highest chroma in the area of green color is a comparatively low of around 40 to 50, and as a result, each direction of conversion of the color data 375 and 378 is

substantially parallel with an achromatic color axis, so that the lightness value increases largely.

Brief Summary Text - BSTX (28):

Thus, in the conventional technology 3, there comes up a problem that when an image fetched through a scanner is displayed on a **CRT** or a result of an image printed by a **printer** is reproduced on a **CRT**, the lightness of color data with low lightness located in the green area largely increases. The result is that the color of the image printed by the **printer** is different from the color displayed on the **CRT**.

Brief Summary Text - BSTX (30):

The present invention has been made for solving the problems described above, and it is an object of the present invention to provide a color data conversion apparatus enabling efficient performance of color data conversion without increase in its lightness when an image fetched through a scanner is displayed on a **CRT** or a result of an image printed by a **printer** is reproduced on a **CRT** as well as to a color data conversion method and a recording medium for the same.

Brief Summary Text - BSTX (31):

In order to achieve the object described above, the color data conversion apparatus according to the invention acquires third color data which is at the

same hue angle as that of first color data within a first color gamut and also has the highest chroma within the second color gamut as well as fourth color data for an achromatic color having the same lightness as that of the third color data by an acquiring unit; and sets target color data on a first line linking the acquired fourth color data to color data corresponding to a black color in the second color gamut, on a second line linking the fourth color data to color data corresponding to a white color in the second color gamut, or on a third line linking the fourth color data to the third color data; and a converting unit converts the first color data to second color data according to the set target color data, so that the first, second, and third lines are insured to be included in the second color gamut, thus the first color data being converted to the second color data without fail. Further, the first color data can be converted to the second color data without fail. In addition, by converting color data toward target color data on the three lines of the first, second, and third lines, it is possible to realize an operation of efficiently converting color data to appropriate one without increase in its lightness when an image fetched through a scanner is displayed on a **CRT** or a result of an image printed by a **printer** is reproduced on a **CRT**.

Brief Summary Text - BSTX (32):
The color data conversion method according to

the invention comprises the steps of acquiring third color data having the highest chroma within the second color gamut as well as fourth color data for an achromatic color having the same lightness as that of the third color data each at the same hue angle as that of first color data within a first color gamut; setting target color data on a first line linking the acquired fourth color data to color data corresponding to a black color in the second color gamut, on a second line linking the fourth color data to color data corresponding to a white color in the second color gamut, or on a third line linking the fourth color data to the third color data; and converting the first color data to the second color data according to the set target color data. Therefore, the first, second, and third lines are insured to be included in the second color gamut, thus the first color data being converted to the second color data without fail. Further, the first color data can be converted to the second color data without fail. In addition, by converting color data toward target color data on the three lines of the first, second, and third lines, it is possible to realize an operation of efficiently converting color data to appropriate one without increase in its lightness when an image fetched through a scanner is displayed on a **CRT** or a result of an image printed by a **printer** is reproduced on a **CRT**.

Drawing Description Text - DRTX (14):

FIGS. 13A and 13B explain the concepts of conventional color data conversion for converting color data included in a color gamut of a **CRT** to color data included in a color gamut of a **printer** on a L*a*b* space.

Detailed Description Text - DETX (2):

Detailed description is made hereinafter for the preferred embodiments of the color data conversion apparatus, color data conversion method, and the computer-readable recording medium with a program making a computer execute the method recorded therein with reference to the attached drawings. Description assumes herein a case where color data within a color gamut of a **CRT** is converted to color data within a color gamut of a **printer**.

Detailed Description Text - DETX (4):

As shown in FIG. 1, in the color data conversion apparatus according to Embodiment 1, there are provided color data 3 having the highest chroma within a color gamut 2 of a **printer,** a line 7 linking between the color data 3 and color data 4 for an achromatic color having the same lightness as that of the color data 3, a line 5 on the L* axis linking between the color data 4 and a black color of a **printer,** and a line 6 on the L* axis linking between the color data 4 and a white color of the **printer,** and each color data within a color gamut 1 of a **CRT** is converted toward color data located on any of the lines 5

to 7.

Detailed Description Text - DETX (5):
Namely, by converting all the color data within the **CRT** color gamut 1 toward the color data on the line 7 as the conventional technology 3, lightness of green, namely of color data having low lightness with a* located in a negative area significantly increases when an image fetched through a scanner is displayed on a **CRT** or when a result of an image printed by a **printer** is reproduced on a **CRT**. Thus, in this color data conversion apparatus, each of the color data within the **CRT** color gamut 1 is converted toward target color data located on any of the lines 5 to 7. As described above, the color data conversion apparatus according to Embodiment 1 does not use only color data on the line 7 as a target for conversion as in the conventional technology 3 but uses the color data on the three lines 5 to 7 as color data for a target for conversion.

Detailed Description Text - DETX (6):
In FIG. 1, the color gamut 1 is a color gamut of a color-displayable **CRT**, while the color gamut 2 is a color gamut of a color-printable **printer**, and color data 8, 11, 14, and 17 are color data as a target for conversion that is not included in the color gamut 2 of the **printer** but included only in the color gamut 1 of the **CRT**. The color data 3 is a color data having the highest chroma

included in the **printer** color gamut 2 at the same hue angle as that of the color data 8, 11, 14, and 17, while the color data 4 is a color data for an achromatic color having the same lightness as that of the color data 3.

Detailed Description Text - DETX (10):

The data accepting section 21 receives a color gamut of a **CRT,** a color gamut of a **printer,** and input color data as a target for conversion (described as "first color data" hereinafter). Then, the data accepting section 21 outputs a color gamut of the **printer** to the reference color data acquiring section 22 and outputs the color gamut of the **CRT,** color gamut of the **printer** and the first color data to the data converting section 23. The data accepting section 21 determines whether the input color data is the first color data as a target for conversion or not, and when it is determined that the data is not the first color data, the processing is terminated without executing conversion processing described later.

Detailed Description Text - DETX (13):

The data converting section 23 converts the first color data within the **CRT** color gamut to color data within the **printer** color gamut after conversion (described as "second color data" hereinafter). This conversion is performed based on target color data located on any of a first line (line 5 in FIG. 1) linking the fourth color data and color gamut

corresponding to the black color of the **printer** obtained from the reference color data acquiring section 22, a second line (line 6 in FIG. 1) linking the fourth color data and color gamut corresponding to the white color of the **printer,** or a third line (line 7 in FIG. 1) linking the fourth color data and the third color data. The data converting section 23 comprises a target color data calculating section 24 and a conversion processing section 25.

Detailed Description Text - DETX (30):

The position calculating section 24c calculates a position of target color data corresponding to first color data located on three lines. More specifically, when the lightness value of first color data is lower than the lightness value of third color data and the fourth lightness difference d is larger than a **chroma-importance constant c, and if the weight factor is 0,** then the position computing section 24c determines a position of fourth color data as a position of target color data. On the contrary, if the weight factor is not 0, then the position computing section 24c determines a position on the first line corresponding to the weight factor as a position of the target color data.

Detailed Description Text - DETX (31):

Further, when the lightness of first color data is lower than the lightness of third color data and the fourth lightness

difference d is smaller than the **chroma-importance constant c, and if the weight factor is 0,** then the position computing section 24c determines a position of fourth color data as a position of target color data. On the contrary, if the weight factor is not 0, then the position computing section 24c determines a position on the third line corresponding to the weight factor as a position of the target color data.

Detailed Description Text - DETX (32):
Furthermore, when the lightness of first color data is higher than the lightness of third color data and the fourth lightness difference d is larger than the **chroma-importance constant c, and if the weight factor is 0,** then the position computing section 24c determines a position of fourth color data as a position of target color data. On the contrary, if the weight factor is not 0, then the position computing section 24c determines a position on the second line corresponding to the weight factor as a position of the target color data.

Detailed Description Text - DETX (33):
When the lightness of first color data is higher than the lightness of third color data and the fourth lightness difference d is smaller than the **chroma-importance constant c, and if the weight factor is 0,** then the position computing section 24c determines a position of fourth color data as a position of target color data. On the contrary, if the

weight factor is not 0, then the position computing section 24c determines a position on the third line corresponding to the weight factor as a position of the target color data.

Detailed Description Text - DETX (41):

Next, on which line the first color data should be converted toward target color data is explained. FIG. 5 is an explanatory view for explaining on which line the first color data should be converted toward target color data. For convenience in description, at first, description is made for conversion when a result of an image printed by a **printer** is displayed on a **CRT,** and the L*a* cross-sectional view is used herein.

Detailed Description Text - DETX (51):

Next, description is made for each position of target color data on three lines 5 to 7 calculated by the target color data calculating section 24 shown in FIG. 3. FIG. 6 explains each position of target color data on three lines 5 to 7 calculated by the target color data calculating section 24 shown in FIG. 3. For convenience in description, it is assumed a case where an image displayed on a **CRT** is printed by a **printer,** and the L*a* cross-sectional view is used herein.

Detailed Description Text - DETX (58):

Then, when the first color data has lower lightness than that of the third

color data 3 and a lightness difference d is smaller than the **chroma-importance constant c, and if the weight factor is 0,** then the target color data calculating section 24 determines a position of color data 4 on the line 5 as a position of target color data, and moves the target color data closer to the position of a black color in the color gamut 2 of the printer if the weight factor becomes larger. As described above, the reason that the target color data is displaced on the line 7 in association with change of the weight factor is because a change rate in a lightness value as well as in a chroma value of the first color data is reduced to be as small as possible.

Detailed Description Text - DETX (60):
When the first color data has lower lightness than that of the third color data 3 and a lightness difference d is smaller than the **chroma-importance constant c, and if the weight factor is 0,** the target color data calculating section 24 determines color data 4 on the line 7 as target color data, and approaches the target color data to the position of the third color data 3 if the weight factor becomes larger.

Detailed Description Text - DETX (62):
Then, when the first color data has higher lightness than that of the third color data 3 and a lightness difference d is larger than the **chroma-importance constant c, and if the weight factor is 0,** the

target color data calculating
section 24 determines a position of target color
data 4 on the line 6 as a
target for conversion, and moves the target color
data closer to the position
of a white color in the color gamut 2 of the
printer if the weight factor
becomes larger.

Detailed Description Text - DETX (63):
When the first color data has higher lightness
than that of the third color
data 3 and a lightness difference d is smaller than
the **chroma-importance**
constant c, and if the weight factor is 0, then the
target color data
calculating section 24 determines target color data
4 on the line 7 as a target
for conversion, and moves the target color data
closer to the position of the
third color data 3 if the weight factor becomes
larger.

Detailed Description Text - DETX (66):
In the figure, a **CRT** 201 is a display device
capable of displaying a color
image, a **printer** 203 is a print device such as a
color ink-jet **printer** capable
of printing a color image. It is assumed that a
color gamut of the **CRT** 201 is
different from a color gamut of the **printer** 203.

Detailed Description Text - DETX (68):
The personal computer 202 sends RGB values of
each pixel forming a color
image to the **CRT** 201 as **CRT**-drive signal and
displays the color image on the

CRT 201. Furthermore, the personal computer 202 converts pixel values (RGB values) of pixels of a color image to CMY values, generates color-**printer** control signal with the CMY values, and makes the **printer** 203 print the color image.

Detailed Description Text - DETX (69):
Further, the personal computer 202 stores therein a look-up table (described as "LUT" hereinafter) 204 for converting colors in a RGB color specification system dependent on the **CRT** 201 to colors in a L*a*b* color specification system, a LUT 205 for converting colors in the L*a*b* color specification system to colors in the RGB color specification system dependent on the **CRT** 201, a LUT 206 for converting colors in a CMY color specification system dependent on the **printer** 203 to colors in. the L*a*b* color specification system, and a LUT 207 for converting colors in the L*a*b* color specification system to colors in the CMY color specification system dependent on the **printer** 203.

Detailed Description Text - DETX (75):
As shown in FIG. 8, the personal computer 202 fetches color data (RGB values) from pixels forming a color image stored in the hard disk or the like not shown herein (step S221). Herein, the RGB values are values for the color space dependent on the **CRT** 201, and all the values that the RGB values can take

form the color gamut 241 of the **CRT** 201 shown in FIG. 9. The CMY values are values for the color space dependent on the **printer** 203, and all the values that the CMY values can take form the color gamut 242 of the **printer** 203 shown in FIG. 9.

Detailed Description Text - DETX (97):

By using the equations described above, when first color data has lower lightness than that of the third color data and a fourth lightness difference is larger than a **chroma-importance constant c, and if the weight factor is 0,** then the personal computer 202 computes the target color data on a position of fourth color data. On the other hand, if the weight factor is larger than 0, then the personal computer 202 computes the target color data on a position moved closer to the color data corresponding to the black color in the color gamut 242 on the first line in accordance with the change in the weight factor.

Detailed Description Text - DETX (98):

When first color data has lower lightness than that of the third color data and a fourth lightness difference is smaller than a **chroma-importance constant c, and if the weight factor is 0** then the personal computer 202 computes target color data on a position of fourth color data. On the other hand, if the weight factor is larger than 0, then the personal computer 202 computes the target color data on a position moved closer to the

third color data on the
third line in accordance with the change in the weight factor.

Detailed Description Text - DETX (99):

Furthermore, when first color data has higher lightness than that of the third color data and a fourth lightness difference is larger than a **chroma-importance constant c, and if the weight factor is 0,** then the personal computer 202 computes target color data on a position of fourth color data. On the other hand, if the weight factor is larger than 0, then the personal computer 202 computes the target color data on a position moved closer to the color data corresponding to the white color in the color gamut 242 on the second line in accordance with the change in the weight factor.

Detailed Description Text - DETX (100):

When first color data has higher lightness than that of the third color data and a fourth lightness difference is smaller than a **chroma-importance constant c, and if the weight factor is 0,** then the personal computer 202 computes target color data on a position of fourth color data. On the other hand, if the weight factor is larger than 0, then the personal computer 202 computes the target color data on a position moved closer to the third color data on the third line in accordance with the change in the weight factor.

Detailed Description Text - DETX (104):

As described above, Embodiment 1 is configured so that the first color data 8, 11, 14, and 17 are converted to second color data by acquiring third color data 3 which is at the same hue angle as that of first color data and also has the highest chroma within a color gamut 2 of a **printer** as well as fourth color data 4 for an achromatic color having the same lightness as that of the third color data 3 and based on target color data 9, 12, 15, and 18 located at any of the first line 5 linking the acquired fourth color data 4 to color data corresponding to the black color in the color gamut 2 of the **printer,** on the second line 6 linking the fourth color data 4 to color data corresponding to the white color in the color gamut 2 of the **printer,** and on the third line 7 linking the fourth color data 4 to the third color data 3, so that when an image fetched through a scanner is to be displayed on a **CRT** or when a result of an image printed by a **printer** is to be reproduced on a **CRT,** color data conversion can efficiently be carried out without increase in its lightness.

Detailed Description Text - DETX (105):

By the way, in Embodiment 1 described above, although all of first color data included in a color gamut of a **CRT** is converted to second color data located on the outermost line of the color gamut of a **printer,** some of first color data should be converted to second color data

locating inside the color gamut of the **printer** on condition that the first color data is located in an inappropriate position for conversion.

Detailed Description Text - DETX (107):

FIGS. 10A and 10B explain the concepts of color data conversion apparatus according to Embodiment 2. As shown in FIG. 10B, in the above mentioned Embodiment 1, when first color data 123 located in the color gamut 121 of a **CRT** is to be converted to color data in the color gamut 122 of a **printer**, the first color data 123 is linked to target color data 124 with a fourth line, and color data 125 located at a point of intersection of the fourth line and the outermost line of the color gamut 122 of the **printer** is determined as second color data.

Detailed Description Text - DETX (109):

Because of the reason, in Embodiment 2, when first color data 133 shown in FIG. 10B is to be converted, a position of second color data 137 is determined according to a distance proportion (l.sub.6 :l.sub.7) between a distance l.sub.6 from target color data 134 to color data 135 and a distance l.sub.7 from the target dolor data 134 to color data 136. Incidentally, reference numeral 131 indicates a color gamut of a **CRT** and reference numeral 132 indicates a color gamut of a **printer**.

Detailed Description Text - DETX (112):
After the step, the processing is followed by the steps of deriving fifth color data 248 having the highest chroma in the color data included in the color gamut 241 of the **CRT** 201 on the equal-level hue surfaces represented by the hue angle value .theta., computing a chroma value C5 of the fifth color data (step S224), deriving third color data 243 having the highest chroma in the color data included in the color gamut 242 of the **printer** 203 on the equal-level hue surfaces represented by the hue angle value .theta., and computing a chroma value C3 thereof and a fourth lightness difference D4 (step S225).

Detailed Description Text - DETX (122):
As described above, Embodiment 2 is configured so that the processing comprises the steps of computing sixth color data located at a point of intersection between the fourth line linking the first color data to the target color data and the outermost line of the color gamut of a **CRT** as well as seventh color data located at a point of intersection between the fourth line and the outermost line of the color gamut of a **printer,** and computing a position of second color data according to a distance proportion between a distance from the sixth color data to the target color data and a distance from the seventh color data to the target color data. Therefore, the first color data can be converted to a more appropriated

position.

Detailed Description Text - DETX (123):
Although there have shown the cases, in Embodiments 1 and 2 described above, where color data within the color gamut of a **CRT** is converted to color data within the color gamut of a **printer,** the present invention is not limited to the above embodiments, and is applicable to color data conversion between various types of color image equipment such as a **printer, a CRT,** and a scanner.

Detailed Description Text - DETX (130):
According to the invention, when a lightness value of the first color data is lower than the lightness value of the third color data and the fourth lightness difference is larger than about 50, a position of the fourth color data is determined as a position of the target color data if the weight factor is 0, a position on the first line corresponding to the weight factor is determined as a position of the target color data if the weight factor is not 0; when a lightness value of the first color data is lower than the lightness value of the third color data and the fourth lightness difference is smaller than about 50, a position of the fourth color data is determined as a position of the target color data f the weight factor is 0, a position on the third line corresponding to the weight factor is determined as a position of the target color data if the weight factor is not 0; when a

lightness value of the first color data is higher than the lightness value of the third color data and the fourth lightness difference is larger than about 50, a position of the fourth color data is determined as a position of the target color data if the weight factor is 0, a position on the second line corresponding to the weight factor is determined as a position of the target color data if the weight factor is not 0; when a lightness value of the first color data is higher than the lightness value of the third color data and the fourth lightness difference is smaller than about 50, a position of the fourth color data is determined as a position of the target color data if the weight factor is 0, a position on the third line corresponding to the weight factor is determined as a position of the target color data if the weight factor is not 0. Therefore, the target color data can be located at an appropriate position according to the weight factor, and when an image fetched through a scanner is displayed on a **CRT** or a result of an image printed by a **printer** is reproduced on a **CRT,** color data conversion can efficiently be carried out without increase in its lightness.

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DOCUMENT-IDENTIFIER: US 6437792 B1

TITLE: IMAGE PROCESSING APPARATUS AND METHOD, COLOR GAMUT CONVERSION TABLE CREATING APPARATUS AND METHOD, STORAGE MEDIUM HAVING IMAGE PROCESSING PROGRAM RECORDED THEREIN, AND STORAGE MEDIUM HAVING RECORDED THEREIN COLOR GAMUT CONVERSION TABLE CREATING PROGRAM

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---------- KWIC ---------

Brief Summary Text - BSTX (6):

There have been proposed various types of devices dealing with color images. However, many of them differ in color gamut they can cover (range of color reproduction) from one to another. Simple transfer of a color image between such devices of different types will result in reproduction of the color image in different colors from the original ones. Suppose for example that an image displayed on a **monitor** is printed out as a **hard copy by a printer**. In this case, if a color gamut the **monitor** covers is different from a one the **printer** covers, the color of an image printed out as a **hard copy by the printer** will be different from that of the image displayed on the **monitor** as the case may be.

Brief Summary Text - BSTX (8):

Referring now to FIG. 1, there is schematically illustrated the concept of the color management system in which physical colorimetric values of color signals in input and output devices are combined to implement a device-independent color. More particularly, as shown in FIG. 1, a color signal from an input device (such as video camera 61, scanner 62, **monitor** 63 or the like) is converted to a color signal in a device-independent color space (CIE/XYZ, CIE/L*a*b* or the like) on the basis of a device profile in which a color gamut conversion formula or color gamut conversion table is defined for each of the input devices. For an output device (**monitor** 63, **printer** 64 or the like) to output the color signal, the latter is

converted to a color signal in
a color space corresponding to the device on the basis of a device profile in
which a color gamut conversion formula or color gamut conversion table is
defined for each of the output devices.

Brief Summary Text - BSTX (11):

The above difference in color gamut will further be described herebelow concerning a **CRT monitor and printer**. Normally, the **CRT monitor** reproduces a color by additive mixture of three color stimuli, namely, red (R), green (G) and blue (B), emitted from their respective phosphors on a face plate. Thus, the color gamut of the **CRT monitor** depends upon the types of the phosphors used on the face plate. On the other hand, the **printer** uses three color inks, namely, cyan (C), magenta (M) and yellow (Y) (or four color inks including black (K) in addition to the three color inks) to reproduce a color. That is, the color gamut of the **printer** depends upon the types of inks used therein. Further, the **printer** color gamut varies depending upon the type of a paper as an image recording medium, the gradation reproducing method, etc.

Brief Summary Text - BSTX (12):

FIG. 2 shows a typical color gamut of **CRT monitor** and a typical color gamut of **printer,** integrated in the direction of L* and plotted in a plane a*-b*. Normally, the **CRT monitor and printer** color gamuts are different from each

other as shown in FIG. 2. As seen from FIG. 2, the color gamut of the **printer** color is generally smaller than that of the **CRT monitor,** and especially in the green and blue color gamuts, the **printer** color gamut is extremely smaller than the **CRT monitor** color gamut. FIG. 3 shows the typical color gamut of **CRT monitor and that of printer,** plotted in a plane C*-L*. Since the peak of the chroma C* in the **CRT monitor** color gamut is away from that of the chroma C* in the **printer** color gamut in the direction of lightness L* as shown in FIG. 3, it is physically impossible for the **printer** to reproduce a color in an area of a high lightness and chroma displayed on the **CRT monitor** even in the domain of a hue in which there is not so large a difference between the **CRT monitor and printer** as in FIG. 2.

Drawing Description Text - DRTX (3):
FIG. 2 shows a typical color gamut of **CRT monitor** and a typical color gamut of **printer,** integrated in the direction of L* and plotted in a plane a*-b*;

Drawing Description Text - DRTX (4):
FIG. 3 shows the typical color gamut of **CRT monitor and that of printer,** plotted in a plane C*-L*;

Drawing Description Text - DRTX (31):
FIG. 30 shows a procedure of signal conversion for effecting a color gamut

reduction after converting an input color signal to a device-independent color signal, the procedure being intended for a case that the input device is a **monitor** while the output device is a **printer**;

Drawing Description Text - DRTX (32):
FIG. 31 shows an example of **monitor and printer** color gamuts;

Drawing Description Text - DRTX (33):
FIG. 32 shows another example of **monitor and printer** color gamuts;

Drawing Description Text - DRTX (38):
FIG. 37 also explains how to set a colorimetric area, using, in this case, an example that a colorimetric area is set relative to the **printer** color gamut when the **monitor** color gamut is partly larger while the **printer** color gamut is partly larger;

Drawing Description Text - DRTX (39):
FIG. 38 also explains how to set a colorimetric area, using, in this case, an example that a colorimetric area is set relative to a common color gamut to both the **monitor and printer when the monitor** color gamut is partly larger while the **printer** color gamut is partly larger;

Detailed Description Text - DETX (48):
Referring now to FIG. 27, there is schematically illustrated an embodiment

angle circumscribing the spectral locus of
the color degree diagram are used to include the
spectral locus of the

of the image processor. The image processor is generally indicated with a reference 10. The image processor 10 is adapted to convert a color signal inputted from a predetermined input device to a color signal in a device-independent color space and then convert the color signal to a color signal which can be dealt with by an output device such as a **monitor, printer** or the like.

Detailed Description Text - DETX (49):

As shown in FIG. 27, the image processor 10 includes a central processing unit (CPU) 11 which effect a variety of data processing, a random access memory (RAM) 12 used as necessary during a data processing by the CPU 11, a first interface 14 controlling interfacing with an external memory 13, a second interface 16 controlling interfacing with a digital still camera 15, a third interface 18 controlling interfacing with a **monitor** 17, and a fourth interface 20 controlling interfacing with a **printer** 19.

Detailed Description Text - DETX (61):

In the above image processor 10, the digital still camera 15 is used as an input device, and **monitor** 17 and **printer** 19 are used as output devices. Note however that devices usable in the present invention are not limited such devices but they may of course be any one which could input and output an image data.

Detailed Description Text - DETX (72):
There will be described herebelow an example that a color gamut reduction in which a **monitor** is used as the input device and a **printer** is used as the output device, for example, as shown in FIG. 30 and a color gamut reduction is made for conversion of a color signal between the **monitor and printer**. However, the input and output devices may of course be other than the **monitor and printer** if only they are ones dealing with color signals.

Detailed Description Text - DETX (73):
An RGB signal R=red, G=green and B=blue) being an input image color signal will be converted by a device profile of the **monitor** to an L*a*b* signal being a device-independent color signal. The L*a*b* is subjected to polar coordinate transformation to an L*C*h signal by which three attributes (lightness, chroma and hue) of a color can be represented. A color gamut reduction is effected in the polar coordinate space, and then the L*C*h signal is converted to L*a*b* signal again. Further, the color signal is converted to cyan (C), magenta (M), yellow (Y) and black (K) being output image color signals to form an image by means of the **printer** being an output device.

Detailed Description Text - DETX (75):
The color gamut reduction effected in the L*C*h color space based on the three attributes (lightness, chroma and hue) obtained through the polar

coordinate transform of a device-independent color space, will be described hereinbelow. Examples of the color gamuts of the **monitor and printer** in a certain hue are shown in FIGS. 31 and 32.

Detailed Description Text - DETX (76):
The patterns of color gamut shape include a one in which the color gamut of the **printer** is completely included in that of the **printer** as shown in FIG. 31 (this color gamut shape will be called "shape 1") and a one in which the **monitor** color gamut has a part thereof larger than the **printer** color gamut while the **printer** color gamut has a part thereof larger than the **monitor** color gamut as shown in FIG. 32 (this color gamut shape will be called "shape 2").

Detailed Description Text - DETX (77):
As in the above, the color gamut varies in shape from one device to another, so that all colors cannot physically be reproduced. The color gamut reduction is to map a **monitor** color gamut not reproducible by a **printer** in a color gamut of the **printer**. The color gamut reduction has to be done in such a manner that an input image will be reproduced to have a more natural appearance. To this end, the three-dimensional color gamut reduction is effected in the linear or nonlinear manner.

Detailed Description Text - DETX (85):
The colorimetric area may absolutely be set

using the parameter K or may be set in relation to the **printer and monitor** color gamuts taken as a reference.
Note that the absolute setting of the colorimetric area is to set the colorimetric area irrespectively of the color gamut shapes of the **printer and monitor**. As shown in FIG. 34, for example, the calorimeter area is set as a triangle passing through the parameter K. On the other hand, the relative setting of the colorimetric area is to set the colorimetric area in relation to the color gamuts of the **printer and monitor**. As shown in FIG. 35, for example, the colorimetric area is set by relatively reducing the **printer** color gamut in a direction.

Detailed Description Text - DETX (87):
In these examples, when the parameter K has a **chroma Ck=0,** no colorimetric area will exist. When the chroma Ck of the parameter K is equal to the maximum chroma Cpmax in the printer color gamut, the colorimetric area will be the entire printer colorimetric area.

Detailed Description Text - DETX (88):
When the **monitor and printer** color gamuts have the aforementioned shape 2, the colorimetric area may be set in relation to the **printer** color gamut as shown in FIG. 37. Otherwise, the colorimetric area may be set in relation to a color gamut common to the **monitor and printer** as shown in FIGS. 38.

Detailed Description Text - DETX (89):
The parameter K may be of any value if only it is within the **printer** color gamut. For example, the parameter K may be set on a lightness determined to have a maximum chroma inside the **printer** color gamut, as shown in FIG. 37. Otherwise, the parameter K may be set on a lightness determined to have a maximum chroma in the color gamut common to the **printer and monitor,** as shown in FIG. 38. Moreover, the parameter K may be set on the straight line extending from the point having a maximum chroma in the **printer** color gamut to a point having a predetermined chromatic value, or it may be set on a straight line extending from a point having the maximum chroma in the color gamut common to the **printer and monitor** to a point having the predetermined chromatic value.

Detailed Description Text - DETX (91):
As in the above, the colorimetric area is set as a not-to-reduced area inside the **printer** color gamut. On the assumption that an area obtained by subtraction of the colorimetric area from the **monitor** color gamut is "area A", an area obtained by subtraction of the colorimetric area from the **printer** color gamut is "area B" and a common area to the areas A and B is "area C", the color gamut reduction is effected by reducing or expanding the area A to the area B and/or C. Note that when the **monitor and printer** color gamuts have the shape 1 as in the above, the areas B and C will coincide

with each other.

Detailed Description Text - DETX (92):
Next, there will be described how the color gamut of the point P existing in the area A is reduced when the **monitor and printer** color gamuts have the shape 1 as in the above. Note that the colorimetric area is set in relation to the **printer** color gamut with the parameter K set on the straight line of lightness of the color gamut having the maximum chroma in the hue plane of the point P.

Detailed Description Text - DETX (100):
In FIG. 45, Cmon indicates a chroma at an intersection of the straight line passing through the points P and Q with the outer wall of the **monitor** color gamut, Cprn indicates a chroma at an intersection of the straight line passing through the points P and Q with the outer wall of the **printer** color gamut, Ccol indicates a chroma at an intersection of the straight line passing through the points P and Q with the outer wall of the colorimetric area, Cpin indicates a chroma at the point P, and Cpout indicates a chroma at the point Q.

Detailed Description Text - DETX (114):
As in the foregoing, a color signal whose ratio between the distance from the outer wall of the colorimetric area and that from the outer wall of the **monitor** color gamut is m:n is mapped along the profile of the output device

imaginary color gamut whose ratio between the distance from the outer wall of the colorimetric area and that from the outer wall of the **printer** color gamut is x:y. The above processing is effected all the to-be-reduced input image color signals. Thus, the linear or nonlinear reduction can be adopted to effect a color gamut reduction using the three-dimensions, namely, lightness, chroma and hue.

Detailed Description Text - DETX (115):

FIGS. 48 and 49 show the concept of the above color gamut reduction. As shown in FIG. 48, a color signal in a certain plane inside the **monitor** color gamut is mapped along the profile of the output device imaginary color gamut corresponding to the plane, and as shown in FIG. 49, the color signal in the certain plane inside the **monitor** color gamut is mapped along the outermost contour of the output device imaginary color gamut corresponding to the plane. That is, an input image color signal is mapped along any profile of the output device imaginary color gamut set inside the **printer** color gamut, whereby the input image color signal is converted to a color signal corresponding to the **printer** color gamut.

Detailed Description Text - DETX (116):

Note that also when the **monitor and printer** color gamuts have the aforementioned shape 2 (namely, the **monitor** color gamut is partially larger

than the **printer** color gamut and the **printer** color gamut is partially larger than the **monitor** color gamut), the nearly same color gamut reduction as in the above can be effected. More particularly, when the **monitor and printer** color gamuts have the shape 2, the color gamut reduction should be done as in the above if the area A (an area obtained by subtraction of the colorimetric area from the **monitor** color gamut) is reduced or expanded to the area B (an area obtained by subtraction of the colorimetric area from the **printer** color gamut). On the other hand, if the area A is reduced or expanded to the area C (a common area to the areas A and B), the **printer** color gamut referred to in the above description should be changed to the common color gamut to the **monitor and printer**.

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See image for Certificate of Correction

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---------- KWIC ---------

Abstract Text - ABTX (1):
A gamut compression method and apparatus for a color DTP system in which more natural-looking color regeneration is achieved in consideration of the difference in gamut from one device to another. If the **gamut** of the output system GMout is smaller than that of the input system GMin, the **gamut** of the

input system is divided into four portions in a two-dimensional plane of **lightness and chroma,** under a constant color hue, using two straight line segments, and **gamut** compression is done by varying the compressing direction for each area, so that the color in the **gamut** of the input system will be converted into the color in the **gamut** of the output system.

Brief Summary Text - BSTX (14):
Among conventional techniques for **gamut** compression, there are a **chroma** compression method in which **lightness** L* is kept constant and only **chroma** C* is compressed, as shown in FIG. 3, a **lightness** compression method in which **chroma** C* is kept constant and **lightness** L* is compressed, and a minimum color difference method of minimizing the color difference in the L*-C* plane, as shown in FIG. 5.

Brief Summary Text - BSTX (20):
According to the present invention, there is provided a method for **gamut** compression in which, if the **gamut** of the output system is smaller than that of the input system, the **gamut** of the input system is divided into four portions in a two-dimensional plane of **lightness and chroma,** under a constant color hue, using two straight line segments, and **gamut** compression is done by varying the compressing direction from one area to another, for converting the color in the

gamut of the input system into the color in the **gamut** of the output system.

Brief Summary Text - BSTX (21):

In a preferred embodiment, the color of the input system is divided into four areas, in a two-dimensional plane of **lightness** L* and **chroma** C* of color picture data in the CIE/L* C* h color space, under a constant color phase h, by a first straight line segment traversing the minimum value L*.sub.-- min of **lightness** L* of the **gamut** of the output system and a second straight line segment traversing the maximum value L*.sub.-- max of **lightness** L* of the **gamut** of the output system. The first and second straight line segments intersect each other at a point (C*.sub.-- th, L*.sub.-- th) on a **lightness** value L*.sub.-- th having the maximum **chroma** value of C*.sub.-- max in the **gamut** of the output system. The color of the first area above the first straight line segment and below the second straight line segment is left as is, while the color of the second area lying above the first and second straight line segments is compressed in the direction of a point (0, L*.sub.-- min). On the other hand, the color of the third area lying below the first and second straight line segments is compressed in the direction of a point (0, L*.sub.-- max), while the color of the fourth area lying below the first straight line segment and above the second straight line segment is compressed in the direction of a point (C*.sub.-- th, L*.sub.-- th).

Detailed Description Text - DETX (7):

That is, the color **gamut** compression processor 32 divides the **gamut** GMin of the input system for the color picture data of the CIE/L* C* into four portions, in the two-dimensional plane of the **lightness** L* and **chroma** C*, under the constant color phase h, using two straight line segments, as shown in FIG. 8.

Detailed Description Text - DETX (51):

The visual sense test was conducted using two sorts of CG images, that is a first image CG1 containing large amounts of yellow and green and a second image CG2 containing large amounts of blue and magenta. As the techniques for **gamut** compression, the conventional methods, that is the **chroma** compression (A), **lightness** compression (B) and the minimum color difference method(C), and the technique shown in FIG. 10 wherein K=0(D), K 0.75(E) and K=1(F), were used. In a dark room not affected by extraneous light, a monitor and a light box were placed in a 90. position centered about 33 panelists of which 19 were male and 14 were female. Two images of different gamut compression techniques, presented on the light box, and an image in the monitor, were presented for comparison to 33 panelists, who were then asked to judge which of the two images were more alike the image on the monitor for all combinations (6.times.5/2=15 combinations). For the images

presented in the light box, an output image of an ink jet printer (A3+, 300 DPI, continuous system) and an output image of a sublimation type printer (A4, 163DPI) were used.

Detailed Description Text - DETX (54):
With the **gamut** compression method of the present invention, if the **gamut** of the output system is smaller than that of the input system, the **gamut** of the input system is divided into four portions in a two-dimensional plane of **lightness and chroma,** under a constant color hue, using two straight line segments, and **gamut** compression is done by varying the compressing direction for each area, for converting the color in the **gamut** of the input system into the color in the **gamut** of the output system, so that **gamut** compression can be done for realization of a more natural-looking image.

Detailed Description Text - DETX (56):
With the **gamut** compression method according to the present invention, in which, in a two-dimensional plane of **lightness** L* and **chroma** C* of color picture data in the CIE/L* C* h color space, under a constant color phase h, the color of the input system is divided into four areas by a first straight line segment traversing the minimum value L*.sub.-- min of **lightness** L* of the **gamut** of the output system and a second straight line segment traversing the maximum value L*.sub.-- max of **lightness** L* of the

gamut of the output system
and intersecting the first straight line segment at a point (C*.sub.-- th, L*
th) on a **lightness** value L*.sub.-- th having the maximum **chroma** value of
C*.sub.-- max in the **gamut** of the output system, wherein the color of the first
area above said first straight line segment and below the second straight line
segment is left as is, the color of the second area lying above the first and
second straight line segments is compressed in the direction of a point (0,
L*.sub.-- min), the color of the third area lying below the first and second
straight line segments is compressed in the direction of a point (0, L*.sub.--
max) and the color of the fourth area lying below the first straight line
segment and above the second straight line segment is compressed in the
direction of a point (C*.sub.-- th, L*.sub.-- th), compression may be achieved
in such a manner that **chroma** will be maintained as far as possible in the high
lightness area, that is in the second area, and in the low **lightness** area, that
is in the third area, and in such a manner that gradation will be maintained to
a certain extent in the high **chroma** area, that is in the fourth area.

Detailed Description Text - DETX (78):

A **gamut** compression apparatus according to the present invention has area
discrimination means for discriminating to which one of four areas obtained
when dividing the **gamut** of an input system in a two-dimensional plane of

lightness and chroma under a constant color phase, using two straight line segments, belongs an input color picture, and **gamut** compression means for carrying out **gamut** compression of converting the color outside the **gamut** of an output system into the color inside the **gamut** of the output system as the compressing direction is varied from area to area based on area discrimination by said area discrimination means. The result is that the colors in the gamut of the input system can be converted into those in the gamut of the output system, in case the gamut of the output system is smaller than that of the input system, by way of gamut compression, in such a manner as to produce a more natural-looking image.

Detailed Description Text - DETX (79):

With the **gamut** compression apparatus according to the present invention, the area discrimination means judges to which of the four areas of the **gamut** of the input system divided by a first straight line segment traversing the minimum value L*.sub.-- min of **lightness** L* of the **gamut** of the output system and a second straight line segment traversing the maximum value L*.sub.-- max of **lightness** L* of the **gamut** of the output system, intersecting the first straight line segment at a point (C*.sub.-- th, L*.sub.-- th) on a **lightness** value L*.sub.-- th having the maximum **chroma** value of C*.sub.-- max in the **gamut** of the output system, belongs color data of the CIE/L* C* h color space in a

two-dimensional plane of **lightness** L* and **chroma** C*, under a constant color phase h, wherein the **gamut** compression means carries out **gamut** compression based on the results of discrimination by the area discriminating means so that the color of the first area above the first straight line segment and below the second straight line segment is left as is, the color of the second area lying above the first and second straight line segments is compressed in the direction of a point (0, L*.sub.-- min), the color of the third area lying below the first and second straight line segments is compressed in the direction of a point (0, L*.sub.-- max) and the color of the fourth area lying below the first straight line segment and above the second straight line segment is compressed in the direction of a point (C*.sub.-- th, L*.sub.-- th). The result is that compression may be achieved in such a manner that chroma will be maintained as far as possible in the high lightness area, that is in the second area, and in the low lightness area, that is in the third area, and in such a manner that gradation will be maintained to a certain extent in the high chroma area, that is in the fourth area.

Claims Text - CLTX (3):

dividing the **gamut** of the input system into four areas in a two-dimensional plane of **lightness and chroma,** under a constant color hue, using two straight line segments, if the **gamut** of the output system is smaller than that of the

input system; and

Claims Text - CLTX (6):

3. The method for **gamut** compression as claimed in claim 1 wherein, in a two-dimensional plane of **lightness** L* and **chroma** C* of color picture data in the CIE/L* C* h color space, under a constant color phase h, the color of the input system is divided into four areas by a first straight line segment traversing the minimum value L*.sub.-- min of **lightness** L* of the **gamut** of the output system and a second straight line segment traversing the maximum value L*.sub.-- max of **lightness** L* of the **gamut** of the output system, said first and second straight line segments intersecting each other at a point (C*.sub.-- th, L*.sub.-- th) on a **lightness** value L*.sub.-- th having he maximum **chroma** value of C*.sub.-- max in the **gamut** of the output system;

Claims Text - CLTX (44):

area discrimination means for determining to which one of four areas an input color plate belongs, the four areas being obtained by dividing the **gamut** of an input system in a two-dimensional plate of **lightness and chroma** under a constant color phase using two straight line segments; and

Claims Text - CLTX (46):

9. The apparatus for **gamut** compression as claimed in claim 8 wherein said area discrimination means judges to which of the

four areas of the **gamut** of the
input system divided by a first straight line
segment traversing the minimum
value L*.sub.-- min of **lightness** L* of the **gamut** of
the output system and a
second straight line segment traversing the maximum
value L*.sub.-- max of
lightness L* of the **gamut** of the output system
belongs color picture data in
the CIE/L*C*h color space, said first and second
straight line segments
intersecting each other at a point (C*.sub.-- th,
L*.sub.-- th) on a **lightness**
value L*.sub.-- th having the maximum **chroma** value
of C*.sub.-- max in the
gamut of the output system, in a two-dimensional
plane of **lightness** L* and
chroma C*, under a constant color phase h; and
wherein

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DOCUMENT-IDENTIFIER: US 6388674 B1

TITLE: Gamut mapping method and apparatus

DATE-ISSUED: May 14, 2002

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DATE FILED: May 21, 1999

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	APPL-DATE
JP	10-148131	May 28, 1998

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Brief Summary Text - BSTX (11):

FIG. 3 shows the result of a comparison between a color gamut GMmon of the CG monitor and a color gamut GMijp of the printer, each obtained by integration in the direction of L* and plotting in a plane of a*-b*. As seen, the color gamut GMijp of the printer is smaller than the color gamut GMmon of the CG monitor. Especially, the G (green) and B (blue)

gamuts are very smaller. As seen from FIG. 3, the peak **chroma** deviates in the direction of **lightness** also in other areas in which the color **gamuts** are not so much different. Therefore, when a color displayed on the CG monitor is reproduced by the printer, it is physically different for the printer to reproduce the color in the areas of a high lightness and chroma on the CG monitor.

Brief Summary Text - BSTX (16):

It is generally said that the **gamut** mapping should preferably be done in a two-dimensional plane of the **lightness** L* and **chroma** C* in the CIE/L*C*h space while the hue h is being maintained constant. More particularly, the **gamut** mapping methods include a **chroma** compression in which only the **chroma** C* is compressed while the **lightness** L* and hue h are being kept constant as shown in FIG. 4, a **lightness** compression in which the **lightness** L* is compressed in a direction of (L*, a*, b)=(50, 0, 0) while the hue h is being kept constant as shown in FIG. 5, and other methods. Further, for a **gamut** mapping by three-dimensional compression of the **lightness, chroma** and hue h as well, it has been proposed to weight the three color difference items (**lightness, chroma** and hue differences) (referred to as "coefficient of compressibility" hereinunder) and then map the **lightness, chroma** and hue in the direction of a minimum color difference.

Brief Summary Text - BSTX (17):
In the **gamut** mapping in which the **lightness or chroma** is compressed with the hue kept constant, such as the **lightness or chroma** compression, an emphasis has to be put on the compression in the direction of **lightness or chroma,** which causes the following problems:

Brief Summary Text - BSTX (19):
To prevent the above as much as possible, the compressions in the direction of lightness L* and C* should be done at reduced ratios, respectively, in a gamut mapping in which the hue h is somewhat changed. To solve this problem, the Inventor of the present invention has disclosed, in the Japanese Published Unexamined Patent Application No. 08-238760, a **gamut** mapping method in which coefficients of compressibility are assigned to the **lightness, chroma** and hue differences, respectively, by weighting. This **gamut** mapping method permits to compress the **lightness** L*, **chroma** C* and hue h in a good balance. However, all data outside the gamut are mapped over the gamut with a result that colors compressed in a same direction are all mapped in a same color, so that they lose the gradation.

Brief Summary Text - BSTX (22):
The above object can be attained by providing a color mapping method of changing, when an output color **gamut** is different from an input color **gamut,**

the input color **gamut** to the output color **gamut** by correcting the color using a predetermined function for a difference in the **lightness**-directional dynamic range and correcting the color by a combination of a three-dimensional compression of **lightness, chroma** and hue and a two-dimensional shrinkage or expansion of the **lightness and chroma**.

Brief Summary Text - BSTX (24):
The above object can also be attained by providing a color mapping apparatus comprising a color mapping means for changing, when an output color **gamut** is different from an input color **gamut,** a color in the input color **gamut** to one in the output color **gamut** by using a color mapping table created by correcting the color using a predetermined function for a difference in the **lightness**-directional dynamic range, and then correcting the color by a combination of a three-dimensional compression of **lightness, chroma** and hue and a two-dimensional shrinkage or expansion of the **lightness and chroma**.

Detailed Description Text - DETX (25):
Two-dimensional Compression: **Gamut** Mapping for **Lightness and Chroma**

Detailed Description Text - DETX (27):
It should be noted that since in an operation done when the color gamut of the output device is smaller than that of the input device, it is expanded to

that of the input device, the operation will be referred to as "two-dimensional expansion" herein. Further, it should be noted that since in an operation done when the color gamut of the output device is larger than that of the input device, it is shrunk to that of the input device, the operation will be referred to as "two-dimensional shrinkage" herein. For this two-dimensional expansion or shrinkage, the input **gamut** is divided by four with a first straight line 1.sub.1 passing through a minimum value point L*_min of the **lightness** L* in the output **gamut** and a second straight line 1.sub.2 passing through a maximum value point L*_max of the **lightness** L* in the output **gamut,** these first and second straight lines intersecting each other at a point (C*_th, L*_th) of the **lightness** value L*_th having a maximum **chroma** value C*_max of the output **gamut** in a two-dimensional plane of the **lightness** L* and **chroma** C* with the hue h kept constant, as shown in FIGS. 14 and 16.

Detailed Description Text - DETX (45):

The algorithm employed in the **gamut** mapping method according to the present invention is such that the three terms (**lightness,** **chroma** and hue differences) in the ordinary color difference formula are weighted (the weighting factors are referred to as "coefficient of compressibility" hereinunder) for **gamut** compression in a direction in which each color difference is minimized. Namely, it is an algorithm for such a color that

when the following formula (4) is used to estimate the color differences, the difference .DELTA.E is minimized.

Detailed Description Text - DETX (63):

The **gamut** mapping method having been described in the foregoing transforms a color of a picture to a color signal for each of the weighted three terms in the color difference formula (**lightness** difference .DELTA.L*, **chroma** difference .DELTA.C*.sub.ab and hue difference .DELTA.H*.sub.ab) to be minimum, thereby permitting to fully keep the characteristics such as contrast, third dimension and vividness of a picture. Also, the method divides a picture into two areas of lightness and chroma with the hue kept constant and compresses each area optimally, thereby permitting to maintain the gradation in an area having a large chroma. Furthermore, the method corrects a lightness-directional deviation between the input and output devices, thereby permitting to prevent a black compression or the like from taking place and keep the gradation of a picture at a low lightness. Thus, the color gamut of the output device can be used to the full extent.

Detailed Description Text - DETX (65):

As having been described in the foregoing, the present invention provides a **gamut** mapping method of changing, when an output color **gamut** is different from an input color **gamut,** the input color **gamut** to the

output color **gamut** by
correcting the color with a predetermined function
for a difference in the
lightness-directional dynamic range, and correcting
the color by a combination
of a three-dimensional compression of **lightness,**
chroma and hue and a
two-dimensional shrinkage or expansion of the
lightness and chroma. Therefore,
even when a color signal outside the output color
gamut smaller than the input
color gamut is supplied, the gamut mapping method
according to the present
invention can transform the input color signal to
the output color gamut while
fully keeping the characteristics such as contrast,
third dimension and
vividness of a picture. Therefore, the present
invention permits to provide an
output device such as a printer, and so forth,
capable of a natural color
reproduction at different types of devices in a
picture input/output system
such as DTP, and so forth.

Claims Text - CLTX (4):
dividing the input **gamut** by four with a first
straight line passing through
a minimum value point L*min of the **lightness** L* in
the output **gamut** and a
second straight line passing through a maximum
value point L*max of the
lightness L* in the output **gamut,** these first and
second straight lines
intersecting each other at a point (C*th, L*_th) of
the **lightness** value L*_th
having a maximum **chroma** value C*_max of the output
gamut in a two-dimensional
plane of the **lightness** L* and **chroma** C* with the

hue h kept constant, thereby
defining an area A above the first straight line and below the second straight
line, an input area B other than the area A and corresponding to the output
color **gamut,** an input area C other than an area corresponding to the output
color **gamut,** and an area D other than the output and input color **gamuts;** and

Claims Text - CLTX (17):

a color mapping means for changing, when an output color **gamut** is different
from an input color **gamut,** a color in the input color **gamut** to one in the
output color **gamut** by using a color mapping table, said color mapping table
created by using a predetermined function for a difference in the
lightness-directional dynamic range, and then combining a three-dimensional
compression of **lightness, chroma** and hue and a two-dimensional shrinkage or
expansion of the **lightness and chroma,** wherein said means includes means for
dividing the input **gamut** by four with a first straight line passing through a
minimum value point L*min of the **lightness** L* in the output **gamut** and a second
straight line passing through a maximum value point L*max of the **lightness** L*
in the output **gamut,** these first and second straight lines intersecting each
other at a point (C*th, L*_th) of the **lightness** value L*_th having a maximum
chroma value C*_max of the output **gamut** in a two-dimensional plane of the
lightness L* and **chroma** C* with the hue kept

constant, thereby defining an area
A above the first straight line and below the second straight line, an input
area B other than the area A and corresponding to the output color **gamut,** an
input area C other than an area corresponding to the output color **gamut,** and an
area D other than the output and input color **gamuts**.

US-PAT-NO: 5991511

DOCUMENT-IDENTIFIER: US 5991511 A

TITLE: Appearance-based technique for rendering colors on an output device

DATE-ISSUED: November 23, 1999

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APPL-NO: 08/ 871487

DATE FILED: June 9, 1997

PARENT-CASE:

This application is a continuation of U.S. application Ser. No. 08/595,404, filed Feb. 5, 1996, now U.S. Pat. No. 5,650,942, which claims priority from U.S. Provisional Application No. 60/011,064, filed Feb. 2, 1996, the entire disclosures of which are hereby incorporated by reference.

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Drawing Description Text - DRTX (13):

FIG. 12 is a V-T-D plot showing **gamut** mapping for an out-of-**chroma** and

out-of-**lightness** situation;

Detailed Description Text - DETX (48):
FIG. 10 is a V-T-D plot showing **gamut** mapping for an out-of-**lightness** situation, i.e., a situation where the color to be rendered has a **lightness** (V value) that is too large for the printer to render at the pixel's **chroma** (r value). Put another way, the pixel designated 130 is above the umbrella surface (the projection in the plane being line 60), but within the maximum chroma limit (defined by maximum chroma line 65). This is shown schematically as the pixel defining a vector 135 that intersects line 60 at a point 140. This manifests itself in the pixel's specified V.sub.pix being greater than V.sub.top for the pixel's r and .theta. coordinates, i.e., V.sub.top for point 140.

Detailed Description Text - DETX (52):
FIG. 11 is a V-T-D plot showing **gamut** mapping for an out-of-**chroma** situation, i.e., a situation where the color to be rendered for a pixel 150 has a **chroma** (r value) that is too large for the printer to render at the pixel's **lightness** (V value). Put another way, the pixel is outside the maximum chroma limit, but still below the umbrella surface (as extended downwardly past the border point).

Detailed Description Text - DETX (54):

FIG. 12 is a V-T-D plot showing **gamut** mapping for a pixel 160 presenting an out-of**-chroma** and out-of**-lightness** situation. This situation is handled in the same manner as the out-of-lightness but within chroma situation discussed above. Pixel 160 is mapped to a point on the umbrella surface that has the same lightness. Again, the darkness is 0.